CHAPTER 19

AIR HANDLING SYSTEMS

19-1. Air handling system design features

An air handling system is a means of providing conditioned air to the space in order to maintain the environmental requirements. Not all air handling systems will contain the components presented in this chapter, nor is there a standard arrangement for the devices and equipment for various facilities. While there is no "one correct way" to design an air handling system, all air handling systems have basic components that are used. To meet the whole sensible and latent cooling needs of a space with the cool air they supply, these systems use air handling units and, in most cases, chilled water coils to give cooled and dehumidified air to the space. These systems may use low-, medium-, or high-pressure air distribution systems. All air systems are subdivided into single-zone, multizone, dual-duct, reheat, and variable air volume systems.

a. Single-zone systems. Single-zone systems serve just one temperature control zone and are the simplest type of all air systems. For this type of system to work properly, the load must be uniform all through the space, or else there may be a large temperature variation. Single-zone systems are, in most cases, controlled by varying the quantity of chilled water or refrigerant, adding reheat, adjusting face or bypass dampers, or a combination of these. If a close control of the humidity is required while in the cooling mode, a reheat system must be used. Figure 19-1 is the schematic for a typical single-zone central air handling system.

b. Multizone systems. Multizone systems are used to serve a small number of zones with just one central air handling unit. The air handling unit for multizone systems is made up of heating and cooling coils in parallel to get a hot deck and a cold deck. For the lowest energy use, hot and cold deck temperatures are, as a rule, automatically changed to meet the maximum zone heating (hot deck) and cooling (cold deck) needs. Zone thermostats control mixing dampers to give each zone the right supply temperature. A typical multizone air handling system is shown on figure 19-2.

c. Dual-duct systems. Dual-duct systems are much like multizone systems, but instead of mixing the hot and cold air at the air handling unit, the hot and cold air are both brought by ducts to each zone where they are then mixed to meet the needs of the zone. It is common for dual-duct systems to use high-pressure air distribution systems with the pressure reduced in the mixing box at each zone. A simple dual-duct system is shown on figure 19-3.

d. Reheat systems. Reheat systems supply cool air from a central air handler as required to meet the maximum cooling load in each zone. Each zone has a heater in its duct that reheats the supply air as needed to maintain space temperatures. Reheat systems are quite energy-inefficient and have become rare in new buildings as the cost of energy has gone up. Most reheat systems are constant volume, thus the reduction of air volume to each zone as the cooling load gets less will keep down the use of the reheat units and reduce energy consumption significantly. Energy may also be saved by automatically resetting the temperature of the cold air, allowing it to rise as the temperature of the outside air falls. More energy savings may be found through the recovery of the refrigeration system's rejected heat and the use of this heat to reheat the air. An example of a reheat system that uses terminal reheat units shows on figure 19-4.

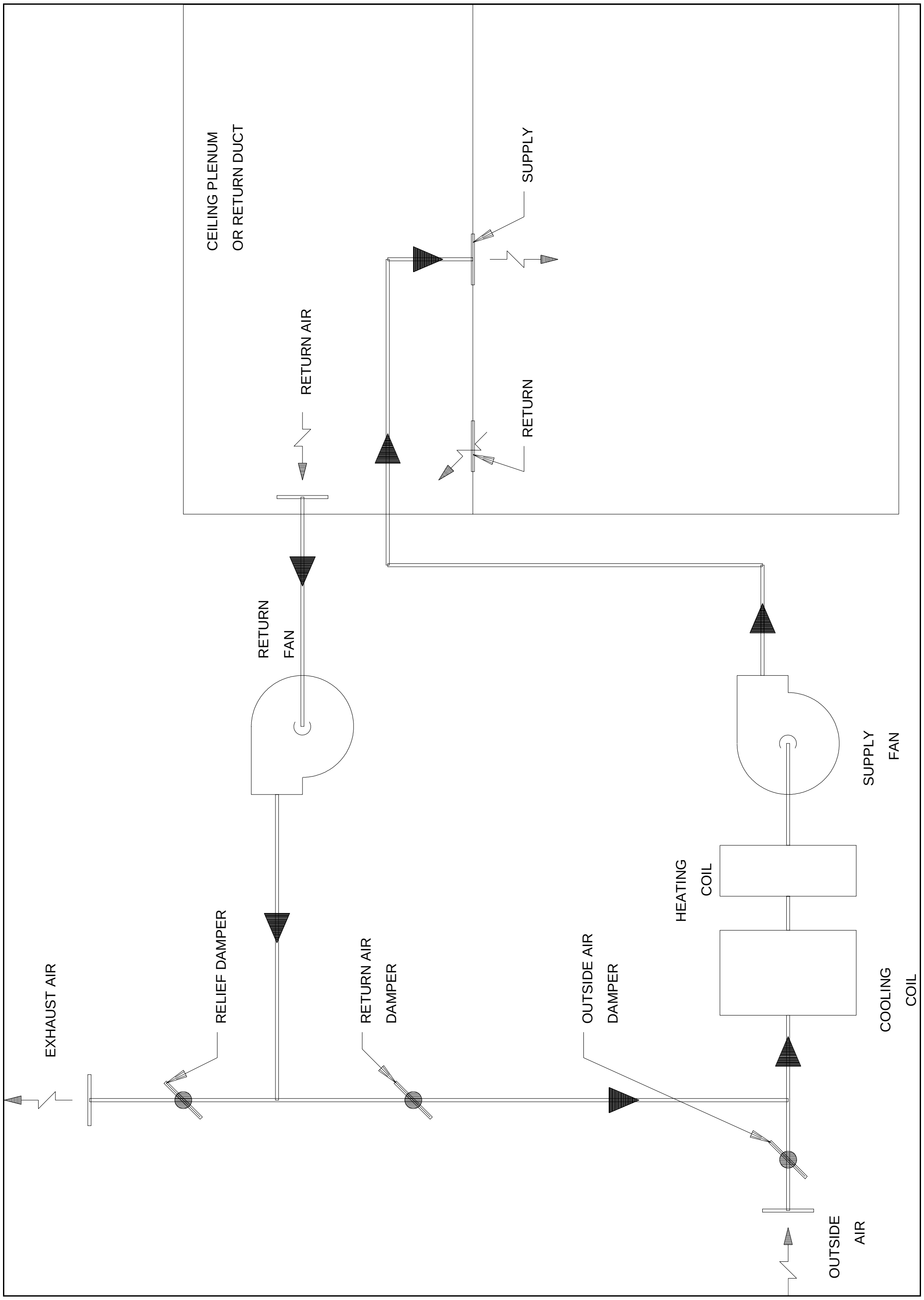

Figure 19-1. Typical single zone air handling system

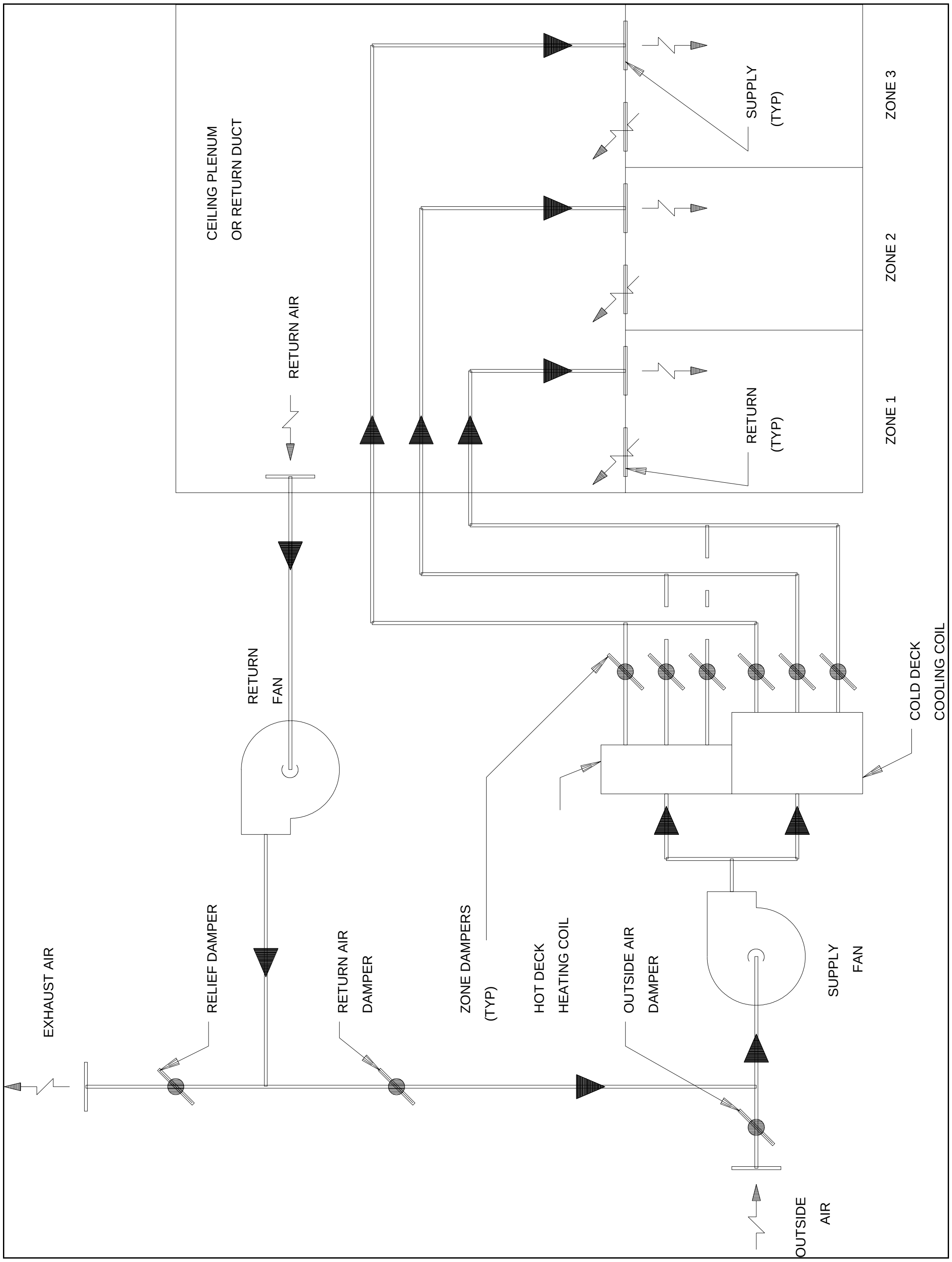

Figure 19-2. Multizone air handling system

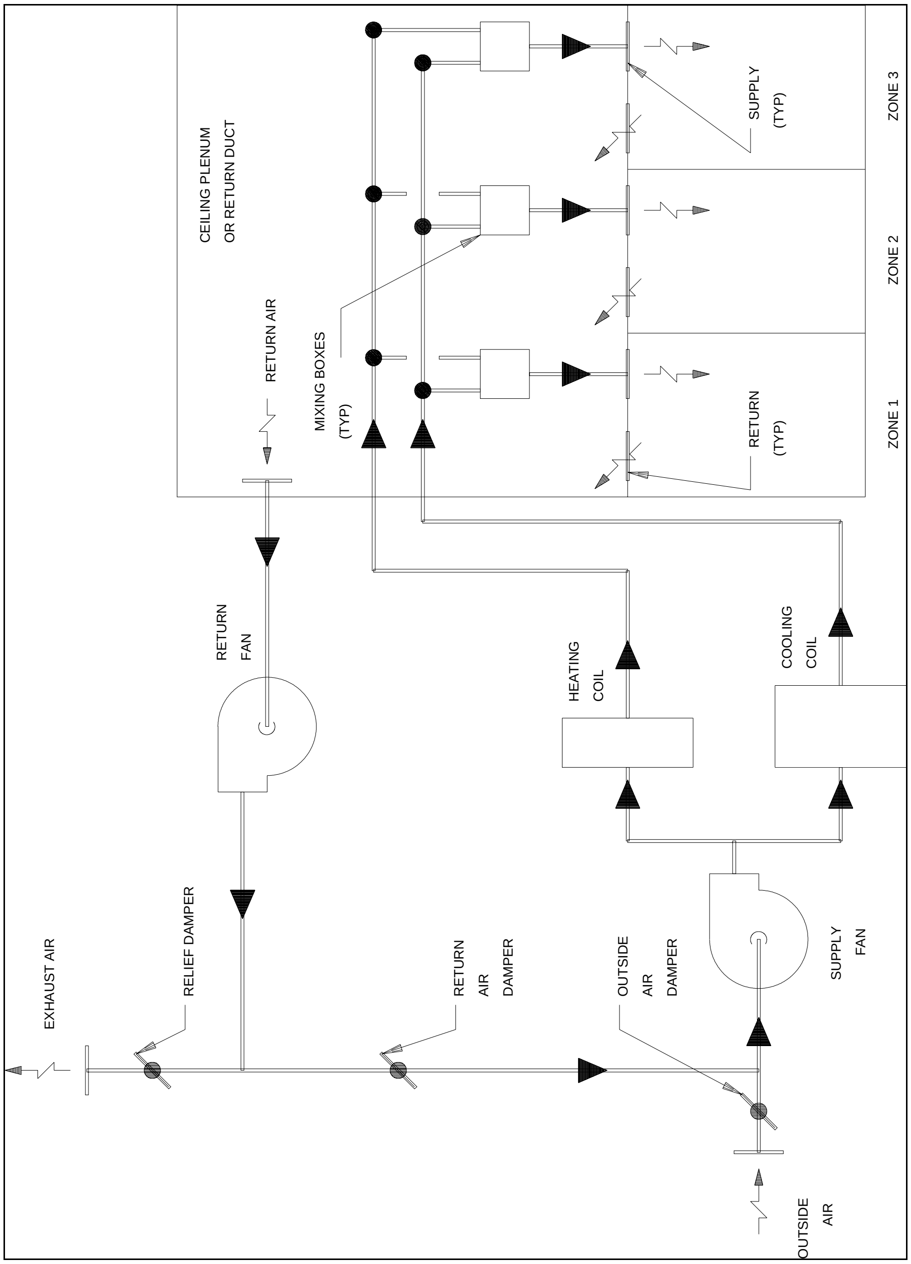

Figure 19-3. Basic dual duct air handling system

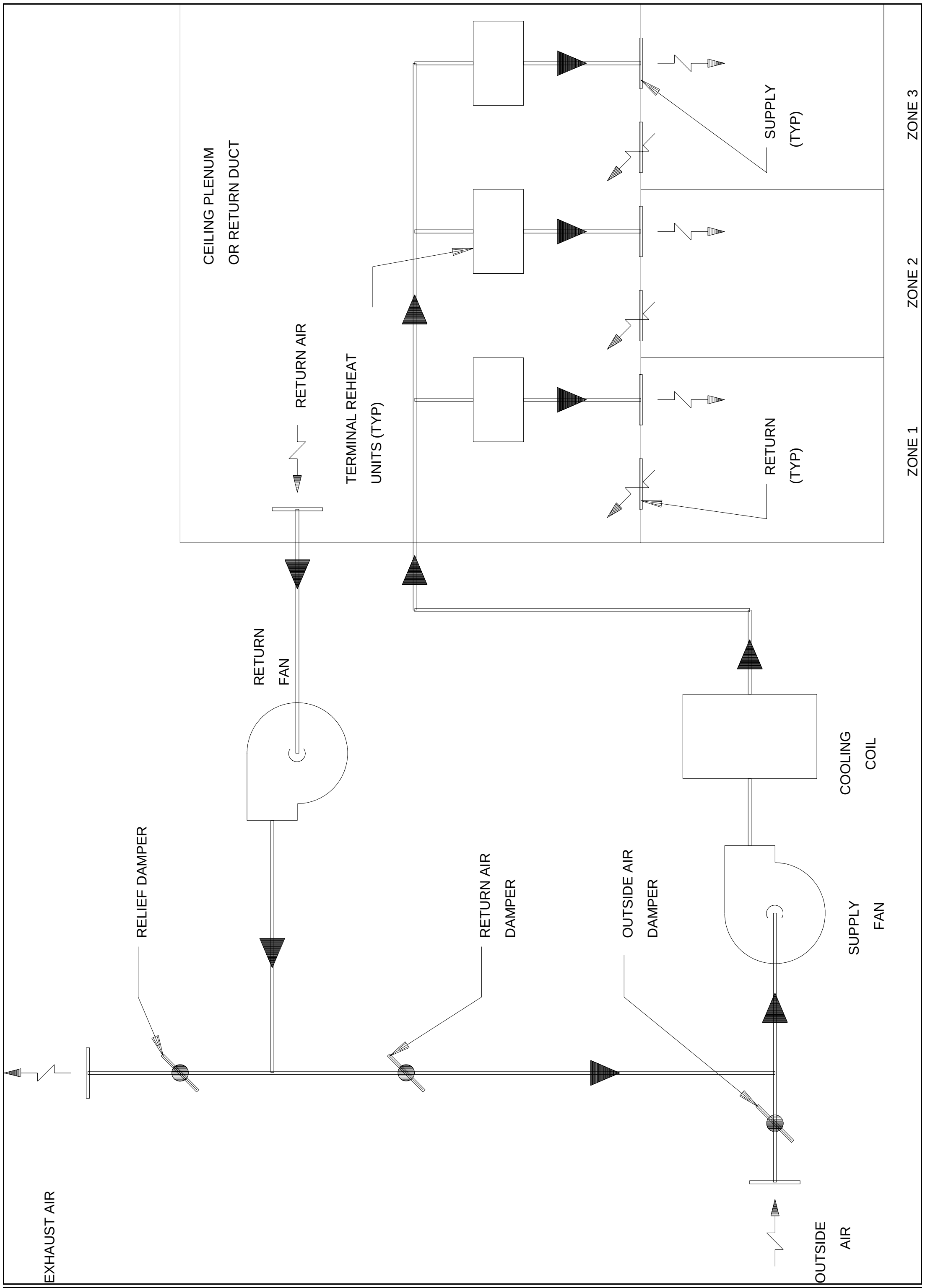

Figure 19-4. Air handling system with reheat

e. *Variable air volume systems*. The one feature that is common to all variable air volume systems is they change the volume of air in response to a change in load, rather than a change in the supply air temperature. Figure 19-5 shows a variable air volume, single-duct, multizone system. Variable air volume systems may change the volume of the whole airflow and/or the volume of each individual zone. Total system airflow may be varied by the use of inlet vanes, discharge dampers, speed control, and variable pitch blades. Zone airflow may be modulated in coordination with total system flow modulation or it may be varied by passing the excess flow right to the return air system with no variation in total system flow. Note that fan horsepower savings, which in most cases are found with variable air volume systems, are obtained from systems which modulate total system volume in response to zone volume modulation.

19-2. Air handling system major components

Air handling systems are comprised of the following major components.

a. *Air handling units*. Air handling units may consist of a supply fan and coil section with a chilled water or direct expansion coil, preheat or reheat coil, heating coil section, filter section, mixing box, or combination mixing box filter section. In some larger units, a return fan may be added to the unit. Air handling units are configured to be either blow-through or draw-through units. Blow-through unit is when one of the coil sections is located downstream of the supply fan. Draw-through unit is when one of the coil sections is located upstream of the supply fan. Draw-through units can be further configured to be either horizontal units or vertical units.

b. *Computer room air conditioners*. Computer room air conditioners are typically factory-assembled units. Indoor units typically consist of fan(s); chilled water or direct expansion coil; steam, electric, or hot water reheat coil; steam or electric humidifiers; and filter section. Hermetic compressor(s) are added to the units when direct expansion coil is used. The outdoor units typically are air-cooled condensing units. Units typically consist of copper tube and aluminum fin coil, direct-drive propeller type fan, and integral electric control panel. On split systems, the condensing unit is the same as described above, except the hermetic compressor is located at the unit instead of being located in the indoor unit.

c. *Chilled water coils*. Fin coils generally consist of rows of round tubes or pipes that may be staggered or placed in-line with respect to the airflow. Flattened tubes or those with other non-round internal passageways are sometimes used. The inside surface of the tubes is usually smooth and plain, but some designs have various forms of internal fins or turbulence devices (turbulators) to improve performance. The individual tubes in a coil are usually interconnected by return bends (U-bends) to form the serpentine arrangement of multipass tube circuits. Chilled water coils usually have aluminum fins and copper tubes, although copper fins on copper tubes are also used.

d. *Hot water coils*. Hot water coils are basically the same as described for chilled water coils. However, the most common circuiting arrangement is often called single-row serpentine or standard circuiting. With this arrangement, all tubes in each coil row are supplied with an equal amount of water through a manifold, commonly called the coil header.

e. *Direct expansion coils*. Coils for refrigerants present more complex cooling fluid distribution problems than water coils. The fin coil that is used for evaporators in most air handling units is typically constructed from copper tubes with aluminum fins. Fin spacings are generally from 6 to 14 fins per inch (2 to 4 mm). Most manufacturers offer a wide choice of fin space and a number of tube rows, usually two to eight in a single casing. The whole tube and fin assembly is enclosed in a galvanized steel casing.

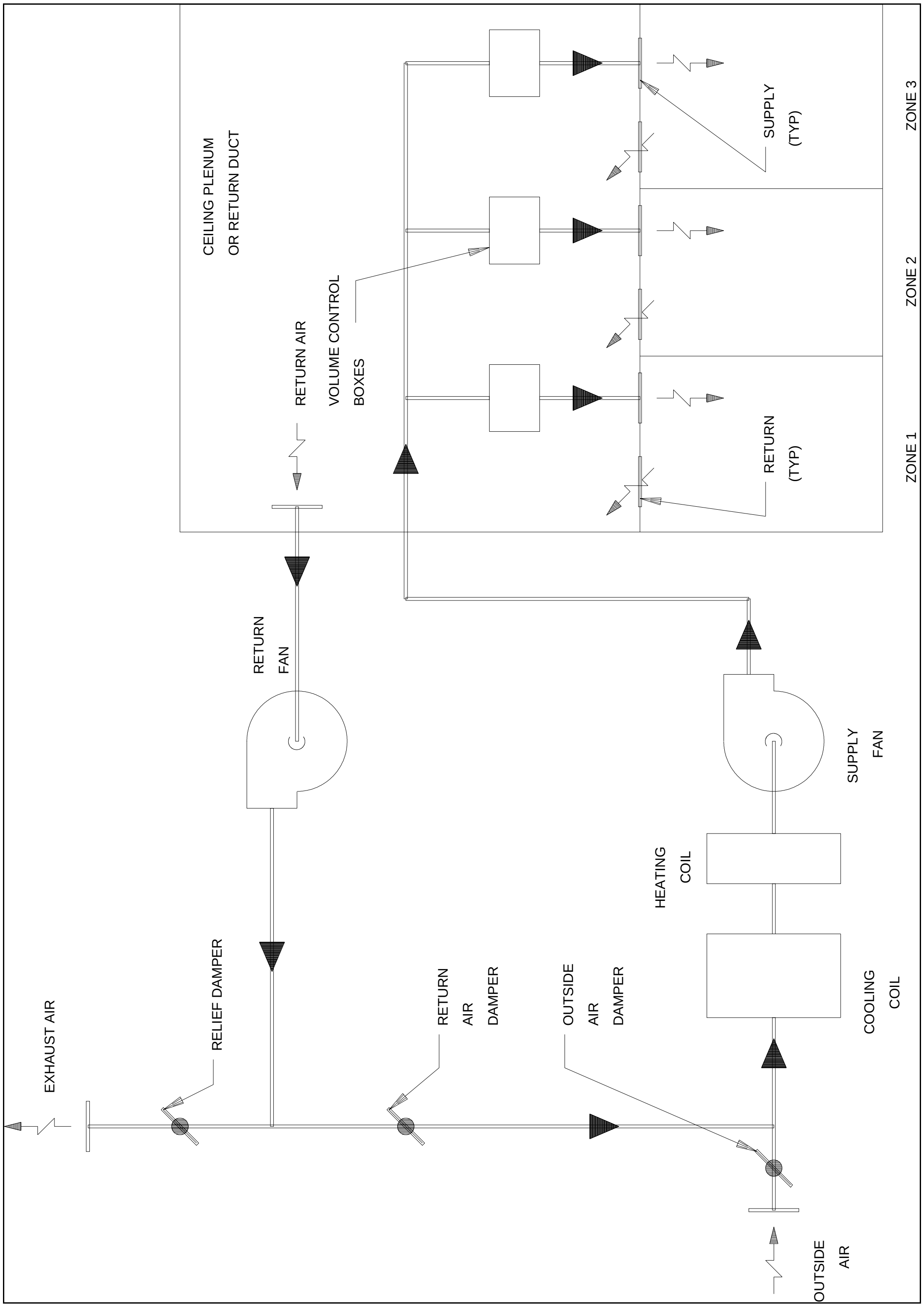

Figure 19-5. Variable air volume air handling system

f. Steam coils. Coils generally consist of a steam header and a condensate header joined by finned tubes. The headers may be both at a side of the unit, with U-bends between them, or sometimes an internal steam tube is used to carry the steam to the remote end of an outer finned tube. Vertical headers may be used with horizontal finned tubes, or sometimes horizontal headers at the bottom of the unit supply vertical finned tubes. Copper and aluminum are the materials most commonly used in the fabrication of low-pressure steam coils. Low-pressure steam coils are usually designed to operate up to 150 to 200 psig (1.0 to 1.4 MPa). For pressures higher than 200 psig, tube materials, such as red brass, Admiralty, or Cupro-Nickel, are used. Tubing made of steel or various copper alloys, such as Cupro-Nickel, are used in applications where corrosive materials or chemicals might attack the coils from either inside or outside.

g. Dehumidifiers. A dehumidification system is one that takes the water vapor from the air. It may do this by cooling the air below its dew point or by chemical means. The more generally used types will be discussed herein. The three most common types of dehumidification equipment are those which use refrigerant liquid type absorbents and solid-state absorbents. The term "absorb" means to drink in or soak up, like a sponge, by chemical or molecular action. The word "adsorb" means to collect in condensed form on a surface and may be done with a gas, liquid, or dissolved substance.

(1) The refrigeration type of dehumidifier is the most commonly used system. Most cooling systems depend on the dehumidification process to take the moisture out of the air, to achieve the desired comfort level in the room. The refrigerated system has its limitations. The coil temperature can only be cooled to the point where the moisture on the coil does not freeze. If the refrigerated system cannot remove enough moisture from the air, other dehumidifiers, such as solid-state absorbents, are typically used.

(2) Solid adsorbents are those which have the ability to make moisture cling to their surface. The products that are used the most are silica gel, activated alumina, and molecular sieve. These desiccant materials will take the water vapor from air or gas with physical or chemical change. The water vapor that they pick up can be released by passing hot dry air across the surface of the product. These products have submicroscopic cavities that hold the particles of adsorbed water vapor.

(3) The systems that use a liquid absorbent to take the moisture from the air are designed to achieve close moisture control in the room that it is serving. These systems can be used as the only means of temperature/humidity control or can be used with a total air-conditioning system to give complete environmental control.

h. Humidifiers. Steam humidifiers are generally used for central air handling systems. But, in order to ensure the advantages of steam humidifiers over other humidifiers, steam humidifiers must provide three performance characteristics: conditioning, control, and distribution. The humidifier must condition the steam to be completely dry and free of significant matter. It must respond immediately to control, provide precise output, and distribute steam as uniformly as possible into the air. Failure of the humidifier to provide these characteristics will result in improper humidification.

i. Three-way control valves. Three-way control valves are usually used in air handling systems to control the flow of chilled water or hot water to their respective coils. The valve has one inlet and two outlet connections, and two separate disks and seats. It is used to direct the flow to either of the outlets or to proportion the flow to both outlets. Generally, this valve is used because the pumping system used must maintain a constant flow, i.e., as the valve closes, the flow to the coil decreases, therefore, the water must be diverted to the return side of the system to maintain constant flow.

j. Control valves. Control valves are designed to control the flow of steam, water, gas, and other fluids within an air-conditioning system. Valves must be properly sized and selected for the particular application. The valves are made of materials best-suited to the fluid handled, depending upon operating temperature and pressure. Internal parts of valves, such as the seat ring, throttling plug or V-port skirt, disk holder, and stem, are sometimes made of stainless steel or other corrosion-resistant metals, depending upon the fluid handled.

k. Fans. Fans are used to move air or other gases or vapors with a fan wheel that makes use of centrifugal or propeller action. Fans can be put into two general classifications: centrifugal fans and axial fans. Centrifugal fans have the flow directed radially outward from the fan wheel. Centrifugal fans are able to move more air at higher pressures and with less noise than axial fans. Axial fan flow is moved parallel to the shaft on which the fan wheel is mounted. All fans have three basic parts: an impeller, motor, and housing. The impeller is the part of the fan that moves the air. In order for an impeller to move air, it must rotate. This is done by power from the motor. Housings are made to fit the individual fan types. Materials used in fan construction are generally steel. They are also built of aluminum and can be made of special materials, such as stainless steel or epoxy-bound fiberglass. Fans can be coated with compounds that are especially suited to the many kinds of corrosive atmospheres in which they must work. In some cases, spark-proof construction is required.

(1) Small fans, especially those whose blades or wheel turn at higher speeds, are equipped with direct-connected motors. For larger size fans, and those that operate at lower speeds, V-belt drives are used. Belt drives have the advantage of giving a lower fan speed than the motor speed and have a built-in shock-absorbing ability.

(2) In some air handling systems, there is a need to change the volume of air that is produced by the fan. Where such a change is made infrequently, the pulley or sheave on the drive motor, or on the fan, may be changed to vary the speed of the fan and thus change the air volume. Dampers may be placed in the duct system to vary the air volume. Variable-speed pulleys and drives, such as electric or fluid drives, may be used to change the fan speed. Two-speed motors and variable fan inlet vanes may also be used to control the airflow rate. Tubeaxial and vaneaxial fans have adjustable blades that vary the airflow rate as required.

(3) A centrifugal fan is built with a wheel that is mounted on a horizontal shaft and turns in a housing. Air enters near the axis of the wheel and is discharged through the housing outlet. Air may enter the fan wheel at one or at both ends of the wheel's axis. The fans that are in use for air- conditioning, heating, and ventilating systems normally do not exceed 10 inches of water (2,488 Pa) static pressure. The main feature that distinguishes one type of centrifugal fan from another is the curvature and the inclination (slope) of the fan wheel blades. The slope largely determines the operating characteristics of the fan. The three principal types of blades are the forward-curved blade, the radial blade, and the backward inclined blade.

(a) The forward-curved blade fans are used primarily for the low-pressure heating, ventilating, and air-conditioning application. Domestic furnaces, low-pressure central station air handling units, and packaged air-conditioning units, such as window and rooftop air-conditioning units, use this type of fan.

(b) In the radial blade fan wheel, the tip of the blade projects straight out from the fan shaft. The radial blade fan can work at a higher pressure than either the forward-curved or the

backward-inclined blade fans. However, to move the same amount of air as the other two types, the radial fan wheel requires more horsepower. Due to its low efficiency, the radial blade fan generally is not found in heating, ventilating, and air-conditioning (HVAC) applications. It is used more for material handling applications, since the wheels are of simple construction and they can be fixed in the field.

(c) In the backward-inclined blade fan wheel, the tip of the blade is inclined backwards away from the direction of the rotation of the fan wheel. This lets the backward- inclined fan move air at higher pressures than the forward-curved fan. It is more efficient (uses less horsepower) for many air volume and pressure ranges than the forward-curved blade fan. The backward-inclined blade wheel is also built with blades that are made in an airfoil shape. This wheel is the most efficient of all types and is the quietest at high static pressure. The backward-inclined fans are generally used in medium to large air handling systems. They are normally used for medium- and high-pressure systems, although they are, at times, used in low-pressure systems.

(4) An axial fan may consist of a fan wheel mounted on a motor shaft or it may have one, or in some cases two, fan wheel(s) mounted on a shaft and confined inside a housing or tube. Axial fans use either a direct drive or a belt drive. The three main types of axial fans are propeller fans, tubeaxial fans, and vaneaxial fans. Axial fans do not develop their static pressure by centrifugal force. The static pressure is gained from the change in velocity of the air when it passes through the fan wheel.

(a) A propeller fan consists of a multiblade impeller within an inlet ring or plate. Propeller fans are low-pressure, high-capacity units built either with the blades mounted on the shaft of an electric motor or a shaft for V-belt drive.

(b) A tubeaxial fan consists of an axial flow wheel within a cylinder or tube. Tubeaxial fans may be used on low- and medium-pressure systems.

(c) Vaneaxial fans are tubeaxial fans with guide vanes that straighten out the axial spiral airflow. Vaneaxial fans can be used in low-, medium-, and high-pressure systems.

l. *Variable air volume terminal units*. A variable air volume system controls the temperature in a space by varying the volume of supply air rather than varying the supply air temperature. Variable air volume terminal units or boxes are used to vary this airflow in each zone or space. There are generally five different types of units that are used: pressure-independent volume units; pressure-dependent, airflow-limiting, maximum volume units; pressure-dependent units; bypass (dumping) units; and supply outlet throttling units. One other type of unit that is used is the fan-powered variable air volume terminal unit.

(1) Pressure-independent volume units regulate the flow rate in response to its respective thermostat's call for heating or cooling. The thermostat controls airflow to the space by varying the position of a simple damper or volume regulating device located in the unit. The required flow rate is maintained, regardless of the fluctuation of the system pressure being supplied by the air handling unit supply fan. These units can be field- or factory-adjusted for maximum and minimum airflow settings.

(2) A pressure-dependent, airflow-limiting, maximum volume unit regulates maximum volume, but the flow rate below maximum varies depending upon inlet pressure at the unit. Generally, airflow will oscillate when system pressure varies. These units are less expensive than pressure-independent units. These units can be used where pressure independence is required only at maximum airflow, where system pressure variations are relatively small, and where some degree of fluctuation or "hunting" is

tolerable.

(3) Pressure-dependent units do not regulate the flow rate, but position the volume regulating device in response to the thermostat. These units are the least expensive and should only be used where there is no need for maximum or minimum airflow control and the air handling unit system pressure is stable.

(4) Generally, in small air handling systems, the cost of a variable air volume system is too high. However, by using bypass (dumping) units in certain zones or spaces, the constant volume system can have variable airflow control. The thermostat controls airflow to the space by varying the position of the volume regulating device. If less air is required to the space, the regulating device closes down and bypasses or diverts some of the air to the return ceiling plenum or return air duct.

(5) Supply outlet throttling units are usually linear diffusers. The area of the throat or the discharge opening varies in approximate proportion to the air volume to maintain throw patterns. The thermostats are usually located at the outlet of the diffuser for easy temperature adjustment. Since these units are pressure-dependent, constant pressure regulators are usually required in the duct system. Noise is a concern when using these units in occupied spaces.

(6) Fan-powered variable air volume units are available in two types: parallel and series flow units. The units have the same components as pressure-dependent or pressure-independent volume units, and in addition, a fan and usually an electric or hot water heating coil. Fan-powered variable air volume units, both series and parallel, are often used for building perimeter heating, because they move more air through a room at low cooling loads and during the heating cycles compared to variable air volume reheat or perimeter radiation systems.

m. Dampers. Dampers are devices used to control or restrict the airflow. They fall primarily into three types: volume, backdraft, and fire dampers.

(1) Volume dampers are devices used to vary the volume of air that passes through an air outlet, inlet, duct, fan, air handling unit, cooling tower, or condenser unit. They may vary the volume from 0 to 100 percent of capacity. Some volume dampers can be opened and closed by hand, while others are opened and closed by a pneumatic or an electric operator. The largest use of manual controlled volume dampers in cooling systems is for air balancing.

(2) Backdraft dampers are devices used to limit the airflow within a duct to one direction and to stop airflow through a duct or opening when the fan is shut off. Backdraft dampers are opened automatically by the force of the airflow on the damper blades. They are closed automatically by a spring or weight counterbalance and by gravity. The counterbalances can be adjusted to allow the damper to pass the needed airflow. Backdraft dampers, because they are free to open and close easily, may rattle and make noise. To eliminate this, felt or vinyl strips can be placed on the damper edges, which will also help minimize the air leakage.

(3) Fire dampers are devices used to close off individual sections of a building during a fire. Fire dampers are normally installed where a duct passes through a wall, partition, floor, or ceiling which is specifically designed to provide fire resistance. If ducts pass through barriers having a fire rating of up to and not more than one hour of fire resistance and can be assumed to present no further fire hazard, there is no need for fire dampers. If the wall, partition, ceiling, or floor is required to have a fire resistance rating for more than one hour, a fire damper is then required to properly protect the opening where the ductwork

penetrates the wall. Fire damper blades are held open by a fusible link (replaceable) during normal operation of the building. If a fire occurs, the fusible link melts and the damper blades close automatically. For a cooling system to operate properly, all fire dampers must be open all the way. Broken or damaged fusible links should always be changed, and fire dampers should never be wired open. Break-away type connections should be used to connect the ductwork to the fire dampers; solid connections should never be used.

(4) Smoke dampers are used for either smoke containment or for smoke control. The damper is basically the same as a volume damper, except the damper is classified and listed in accordance with Underwriters Laboratories, Inc. (UL) 555S, UL Standard for Safety Smoke Dampers Fourth Edition (1999). The damper is a two-position damper, i.e., the damper is either open or closed depending upon the control requirements. The dampers are opened and closed by a pneumatic or electric operator. The damper usually has low leakage characteristics.

n. *Unit heaters*. A unit heater is an assembly of a fan and motor, a heating element, and an enclosure whose function is to heat a space. Generally, unit heaters use five different types of heating media: steam, hot water, gas indirect-fired, oil indirect-fired, and electric. Propeller fan units are the most popular units used; however, sometimes centrifugal fan units are used. Unit heaters are used for spot or intermittent heating, such as large outside doors. Unit heaters are used to heat garages, factories, warehouses, stores, etc.

o. *Ductwork*. Ductwork is the system of ducts and ductwork accessories that are used to connect air handling units and fans with the rooms, spaces, or exhaust hoods with which they are associated. The material used for a duct system must be based on the availability of the material, expertise of the duct installer, the type of duct already installed, the location of the installed duct, and the environment it is planned to be used in. For example, a fume hood that handles corrosive fumes should be connected with a non-metallic polyvinyl chloride (PVC) or stainless steel duct. Metallic ducts are usually built from sheets of aluminum or galvanized steel. The ducts may either be built with round or rectangular cross sections. Non-metallic ducts are usually built from fiberglass duct board, except for ducts handling corrosive fumes that are constructed from a PVC material. Fiberglass duct board sheets are generally in locations where the duct will not be damaged by objects or personnel. All joints should be sealed with a special pressure-sensitive tape made for this purpose; standard duct tape should not be used. Round PVC duct systems are built from standard PVC duct and standard fittings. Fittings and ducts are connected with glue. Rectangular PVC ducts are of a special construction and should be made by people who are skilled in this work. Flexible ducts can be bought and used directly without further fabrication. They are available either insulated or noninsulated.

p. *CBR filters*. CBR (chemical-biological-radiological) filters remove chemical and biological agents and radioactive particles from the intake air. Many blast-protected air intake systems allow intake air to bypass the CBR filter elements when the blast protection system is not in the blast mode of operation. While this prevents the performance of the CBR filters from being impaired by a buildup of dirt, the activated carbon filter element deteriorates from exposure to air over time and requires replacement on a regular basis, even if the filter bank has not been in service.

q. *Air filters*. All of the air that is drawn into an air handling system is "contaminated" to some degree. Such contamination may be as solid particles, liquids, fumes, smoke, or bacteria. The process used to remove these contaminants from the air mechanically, electrically, or by absorbing them, is called air filtration.

(1) Viscous impingement filters are of the panel or roll type with a viscous (tacky) coating on the media to hold the particles to the media. The coating is called an adhesive. Viscous impingement filters are made to trap large dust particles from the airstream. Most air-conditioning systems have this type of filter. There are four types of these filters: throwaway, cleanable, automatic renewable media, and automatic self-cleaning media.

(2) Dry media filters, as their name suggests, do not have the tacky coating that is on viscous impingement filters. The dry media filters take out particles from the air by interception and straining. Interception means to filter out particles using the natural forces of attraction between molecules. Straining means to take out particles that are too large to pass through the openings between the fibers.

(3) A filter made of activated carbon will get rid of solid particles, as well as odor-causing gases and bacteria from the airstream. It is possible to clean and reuse the carbon filters. However, this is best done by the manufacturers, who will take out the carbon and process it to be used again.

(4) The inability of standard dry or viscous type filters to take out fine dust particles from airstreams has led to the development of the electrical precipitator. The precipitation method consists of giving an electrical charge to each dust particle in the airstream by passing the air between electrodes and then collecting the dust on parallel plates as the air flows between the plates.

r. Condensers and condensing units. Condensers can be put in the following groups: water-cooled, air-cooled, and evaporative. The term "evaporative," when used in reference to the condensing process, refers to the cooling effect brought on by the natural evaporation of water exposed to air currents. The heat rejected by a condenser comes from the heat absorbed by the evaporator and the heat of compression that is added by the compressor. Since the compressor and condenser work as one to compress and condense refrigerant vapor, these two parts, when combined into one package, are called a condensing unit.

(1) Shell-and-tube condensers are used for most of the water-cooled refrigeration systems. The shell-and-tube type of water-cooled condenser is like the direct expansion water chiller. But most shell type water-cooled condensers have the cooling water flowing inside the tubes, and the refrigerant that it condenses is inside the shell, but outside the tubes.

(2) Air-cooled condensers are most popular in areas where water is in short supply, where there is a costly water supply, or where the use of water for air conditioning is restricted at times. They also find wide use in those jobs where low maintenance is a prime need. In addition, air-cooled condensers are used in a lot of installations, because they keep down the cost and do away with the installation of water pipe. They also do not require drainage to keep them from freezing in areas where the climate changes a lot and the cooling system must be turned on and off several times in a year. Propeller fan air-cooled condensers use a fin-and-tube coil like the coil described in the Direct-Expansion Coils section. The refrigerant vapor is condensed inside its tubes by giving up heat to air which flows across the coils. These condensers are, in most cases, placed outdoors, or at least the air is taken to the outdoors.

s. Diffusers, registers, and grilles. These are devices used in air handling systems for the supply, return, and exhaust air at intakes and outlets.

t. Pumps. The type of pump used to distribute chilled or hot water through the coils in air handling units varies with the system design. There are two basic types of pumps: positive displacement and centrifugal.

u. Airflow control devices. Devices that sense the condition of air in a space or in an airflow system act upon other devices to make the air behave in the manner desired.

(1) A thermostat or other temperature control device may move a damper that directs the path of an airstream. It may also change the temperature of an airstream by directing its flow through a coil, or it can control the volume of air flowing in a duct system. Through the action of a valve, it also may change the temperature of an airstream.

(2) Pressure controls operate to control the pressure of air in a room, or the duct system through the action of dampers. Figure 19-6 shows how a static pressure controller, along with thermostats and dampers, can be used to control static pressure in a variable volume system. The damper being controlled is in the inlet duct to the supply fan, but it could equally well be an inlet vane damper or an outlet damper. The pressure controller could also operate a blower drive speed control. In this control, the pitch of motor and fan pulleys is varied by a device in response to a signal from the pneumatic static pressure controller.

(3) Control of fan speed to control pressure and airflow volume results in less noise than when inlet vanes or outlet dampers are used. In certain installations, the use of speed control also cuts down the horsepower that is needed by the fan or blower drive motor.

(4) Airflow switches are mounted on the side of a duct with the blade inserted into the duct. The blade of the switch will move according to airflow in the duct, and it will make electrical contacts when air flows and break the contacts when airflow stops. The sensitivity of the switch to the airflow may be adjusted. Another control for the same purpose as the ones described above is the differential pressure switch that senses velocity pressure in the duct. This controller also has an adjustable pressure range.

v. Valves and piping. Valves installed in the air handling system are to control water flow and to isolate equipment for ease of operation and maintenance.

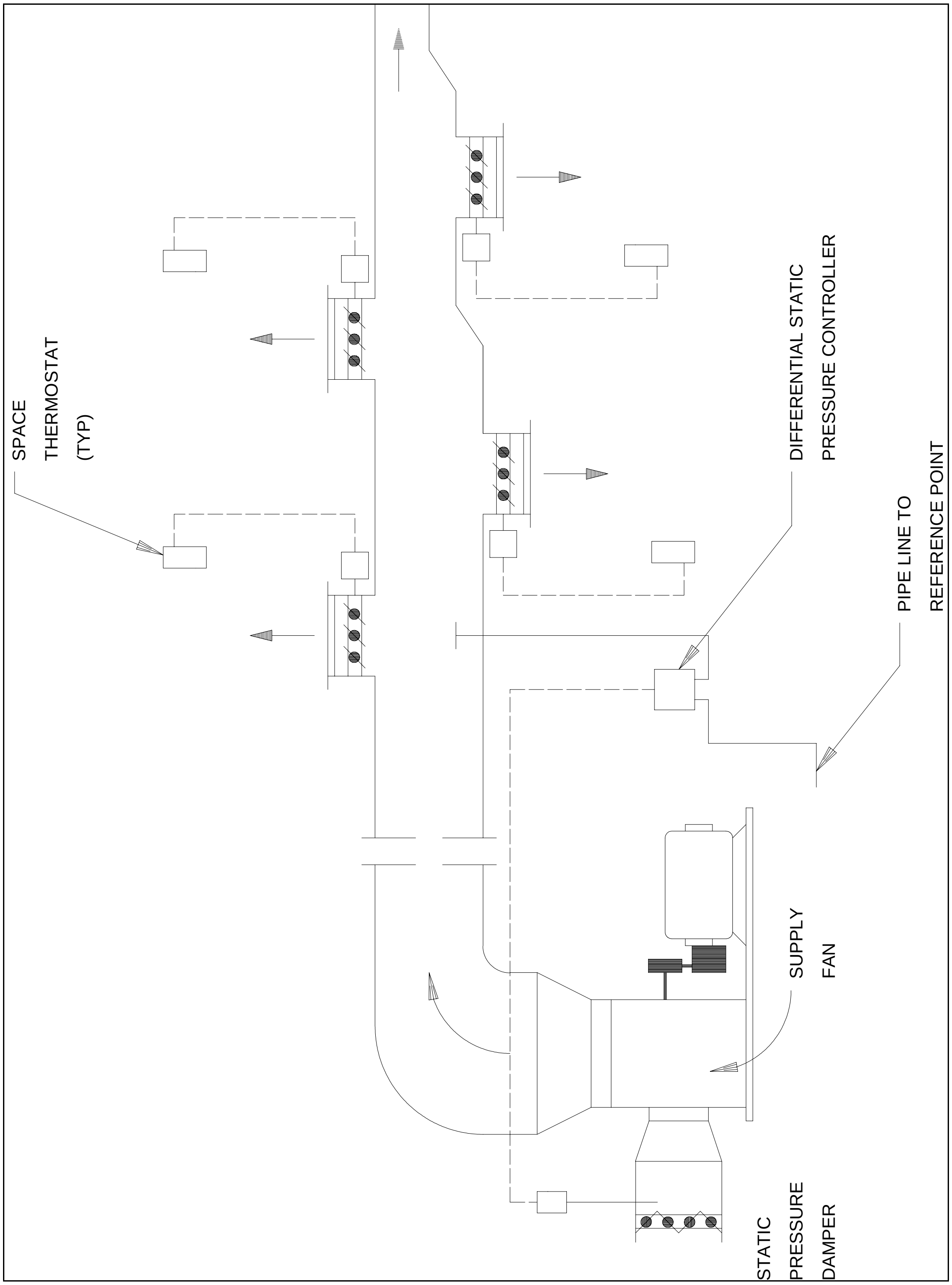

Figure 19-6. Typical air handling systems controls